

Relationship of the Shelfbreak Jet to the Adjacent Slopewater Circulation in the Middle Atlantic Bight

Robert S. Pickart

Department of Physical Oceanography, MS #21

Woods Hole Oceanographic Institution

Woods Hole, MA 02543

phone: (508) 289-2858 fax: (508) 457-2181 mail: rpickart@whoi.edu

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LONG-TERM GOALS

The long-term goal is to understand the variability, forcing, and dynamics of the shelfbreak current and how this impacts the propagation of sound across the shelfbreak. Of particular interest is how the offshore slopewater circulation impacts the shelfbreak current.

OBJECTIVES

The main objectives of this study are (1) to elucidate the nature and cause of the fluctuations of the shelfbreak current, including the role of the bottom boundary layer, and (2) to determine the mean and fluctuating currents/water-masses on the adjacent continental slope, with emphasis on the coupled nature of the slopewater circulation and shelfbreak current.

APPROACH

This study is part of the Shelfbreak PRIMER experiment addressing the acoustics and physical oceanography of the shelfbreak front and adjacent slopewater in the Middle-Atlantic Bight. The fieldwork consisted of long-term moored observations both at the shelfbreak (two upward-looking ADCPs) and on the continental slope (three tall VACM moorings), supplemented by repeat shipboard velocity measurements and hydrography. All measurements were carried out along TOPEX altimetric track C126 (near 70°W) over a two year period from December 1995 to December 1997.

WORK COMPLETED

All the moored, shipboard, and hydrographic data are fully processed and calibrated, and we are immersed in the analysis. The initial emphasis has been on describing the shelfbreak jet using the hydrography and shipboard ADCP measurements. Two separate studies begun last year are now complete, resulting in two recently submitted manuscripts. We are now turning our attention to the moored data to quantify the slopewater circulation and investigate the notion of slopewater forcing of the shelfbreak jet.

RESULTS

(i) Bottom Boundary Layer Of The Shelfbreak Jet

Last year's report described a technique we developed to identify and map the detached bottom boundary layer (BBL) of the shelfbreak jet using CTD data. This was applied to a springtime CTD section which showed the detached BBL extending surprisingly far into the interior of the water column. This year we have investigated the relationship of the detached BBL to the shelfbreak jet, and have found a probable cause for the pronounced extent of the detached BBL. Using the shipboard ADCP data we quantified the cross-shelf flow of the shelfbreak jet (during one realization), revealing a robust, deep secondary circulation cell (Figure 1). It is clear that the upwelling associated with this cell enhances the flow along the detached BBL, which will help advect near-bottom fluid parcels far into the jet interior. Interestingly, the strength of this upwelling is much stronger than that due to convergence in the BBL itself, though at this point the nature of the deep interior cell is not fully understood. It is likely related to the local topography of the shelfbreak, a notion which needs further study.

(ii) Structure And Variability Of The Shelfbreak Jet

Using our collection of shipboard ADCP crossings of the shelfbreak we constructed a “synoptic mean” section of the shelfbreak current in a stream-wise coordinate frame (following the methodology of Hal-kin and Rossby, 1985). This is the first-ever such highly-resolved view of this current, which showed some surprising features (Figure 2). The jet extends to the bottom – its axis tilted with depth – with a surprisingly large equatorward transport of nearly .5 Sv. The jet is convergent throughout the water column, with increased convergence near the surface and bottom. The latter results in the enhancement of the detached BBL as discussed above. The dominant variability of the jet revealed by the sections is characterized by the jet periodically retracting off the bottom to a surface trapped (weakly convergent) state, in which case the jet transport is significantly less. The cause of this variability is presently under investigation, though it appears that it is not simply due to meandering of the jet.

(iii) Slopewater Circulation

This study has only recently been initiated, and involves analysis of the slopewater moored array data. Several interesting features of the data have already been noted and will be pursued. The mean flow is equatorward throughout the water column, although several Gulf Stream rings passed through the study area over the two-year period. The impact of the rings was felt far onshore, and it is of interest to see if the shelfbreak jet itself reacted to the presence of the rings (this will be done using the concurrent shelfbreak moored data). Topographic Rossby waves are also present in the slopewater, and this signal will be carefully investigated as well.

IMPACT/APPLICATIONS

A significant amount of modeling has been carried out over the last decade on the dynamics of the BBL and its impact on the shelfbreak jet. Our results have revealed that a strong near-bottom secondary circulation of the jet can play a major role in the system as well, motivating the need for further modeling. Among the aspects that will have to be considered are the role of topographic variations (which are present throughout the Middle Atlantic Bight) and the importance of lateral variations in the ambient stratification. Our mean synoptic section of the shelfbreak jet is presently being used in a numerical study (S. Lozier, Personal Communication) of the stability of the shelfbreak current.

TRANSITIONS

None.

RELATED PROJECTS

The shelfbreak PRIMER is a collaborative experiment between acousticians and physical oceanographers, and there has been extensive interaction between the various groups. The insights provided by the SeaSoar data (G. Gawarkiewicz, personal communication) have been of great help in our analysis of both the bottom boundary layer and jet velocity structure.

REFERENCES

Halkin, D., and T. Rossby, 1985. The structure and transport of the Gulf Stream at 73°W. *Journal of Physical Oceanography*, **15**, 1439–1452.

Figure 1: Secondary Circulation

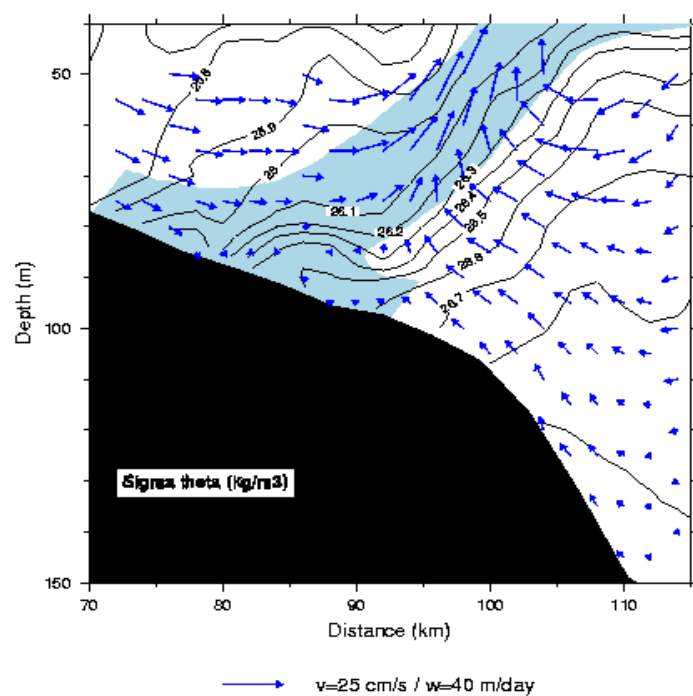


Figure 2: Stream-coordinate Mean Jet

